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Contract AFO4(695)-150

TITAN III/MOL COMPATIBILITY

REQUIREMENTS PROGRAM PLAN (U)

SSD-CR-65-67, Rev 2

15 September 1965

**DOWNGRADED AT 3 YEAR INTERVALS;  
DECLASSIFIED AFTER 12 YEARS  
DOD DIR 5200.10**

MARTIN COMPANY  
Denver, Colorado

Aerospace Division of Martin-Marietta Corporation

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FOREWORD

This document is submitted in accordance with Contract AF04(695)-150 Item 1, Exhibit A, Task 5.13, Line Item 3A-31 of Contractor's Specification SSS-TIII-010 DRD (Rev 3), dated 15 April 1963, DSCNs 1 thru 93.

This document supersedes and replaces SSD-CR-65-67, Rev 1, dated 30 July 1965.

This revision incorporates the comments of SCDs S3-3068B dated 2 September 1965 (Martin Ref: 5-W-13118), D3-3066B dated 2 September 1965 (Martin Ref: 5-W-13117), and P3-3097A dated 2 September 1965 (Martin Ref: 5-W-13127).

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PROGRAM PLAN FOR TITAN III/MOL COMPATIBILITY REQUIREMENTS

1. SCOPE

1.1 (U) General - The contractor shall perform the necessary engineering, reliability, crew safety, and operational analysis, limited testing, coordination, preparation, and submission of changes or additions to existing Titan III specifications and plans to meet the requirements and objectives specified herein. The effort to be included herein shall not duplicate, but shall use the results of, studies, analyses and tests previously performed by the contractor under Contract AF 04(695)-604, Manned Orbiting Laboratory (MOL) Titan III Pre-Phase I Study; Contract AF 04(695)-150, The Manned Orbiting Laboratory Early Flight Test Program (MOL-EFT); and other appropriate studies, analyses and tests performed by the contractor. The contractor shall effect liaison with the Laboratory Vehicle (LV) contractor (to be designated), and the Gemini B contractor (McDonnell Aircraft Corporation) as well as with other Program 624A contractors to assure interface/system technical and operational compatibility.

1.2 (U) Background and Purpose - The current Titan III provides a Malfunction Detection System (MDS) which senses potential catastrophic malfunctions and initiates an automatic abort sequence. The decision to eliminate the MOL escape tower and to provide for manual abort places new requirements on the Titan III and requires a reassessment of all potential booster malfunctions to insure crew safety compatible with the overall Titan III/MOL System. In addition, it appears practicable to incorporate certain modifications that will significantly increase mission success probabilities thus requiring fewer SSLV-5s to accomplish the desired program. Thirdly, in view of known and anticipated increased performance requirements, it is desirable to consider incorporation of other modifications at this time. These modifications are subsequently grouped according to (a) crew safety, (b) mission success, or (c) increased performance; however, many modifications may affect more than one category.

2. (U) OBJECTIVE

The objective of the modification to existing hardware/procedures is to provide the MOL System (Program 624A) with a proven man-rated booster that meets the MOL System operational requirement consistent with schedule, economy, safety and state of the art.



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## 3. REQUIREMENTS

### 3.1 Airborne Launch Vehicle

3.1.1 (C) The launch vehicle configurations in Table 1 shall be capable of injecting minimum payloads into an 80 nautical mile circular orbit at a 90 degree inclination when containing Titan III R&D instrumentation and telemetry.

Table 1 Configuration Identification

| Launch Vehicle Configuration | Stage 0 SRM      | Stage I Engine | With T/S | Payload     |           |             |
|------------------------------|------------------|----------------|----------|-------------|-----------|-------------|
|                              |                  |                |          | Length (ft) | C.G. (ft) | Weight (lb) |
| 1 (I <sub>S</sub> )          | 7-Segment 120" D | 15:1           | Yes      | 54.5        | 29.6      | -           |
| 2 (I <sub>L</sub> )          | 7-Segment 120" D | 15:1           | No       | 74.5        | 47.7      | -           |
| 3 (II <sub>S</sub> )         | 2 Ctr Seg 156" D | 8:1            | Yes      | 58.5        | 31.7      | -           |
| 4 (II <sub>L</sub> )         | 2 Ctr Seg 156" D | 8:1            | No       | 78.5        | 50.1      | -           |
| 5 (III <sub>S</sub> )        | 3 Ctr Seg 156" D | 8:1            | Yes      | 61.0        | 33.1      | -           |
| 6 (III <sub>L</sub> )        | 3 Ctr Seg 156" D | 8:1            | No       | 81.0        | 51.3      | -           |

Note:

1. Values for payload length and C.G. denote distance forward of the Titan III/MOL Interface. (If structural limits do not permit the payload length associated with a Stage 0 configuration, alternate combinations shall be utilized)
2. In the event of staging difficulties with the 156-inch SRM and the 8:1 nozzle, various methods of improving the staging margin shall be investigated.
3. Payload weights will be determined during the course of this study and furnished to the government by the contractor.
4. A 15:1 Stage I engine should be a consideration for a 2 and 3 segment 156-inch SRM for NPSH problem at staging.

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## 3.1.2 (Deleted)

3.1.3 (C) The booster system, including the airborne and ground (real time) malfunction detection systems shall be designed to meet the following criteria:

- a. Between solid motor ignition and laboratory activation, the probability of failure with a warning time less than 3 seconds (including undetected failures) shall not exceed 1.8 per 1000.
- b. Between 40 and 90 seconds, the probability of a failure with a warning time between 3 and 6 seconds shall not exceed 3.15 per 1000.
- c. Warning time is the time between signalling the spacecraft of need to abort and (1) start of structural breakup in the booster, or (2) exceeding the ejection system or other spacecraft constraints.

3.1.4 (U) All launch vehicle systems including the laboratory vehicle and Gemini B shall be capable of being tested and launched using the full ITL and/or ILC system at WTR. The compatibility studies herein shall be limited to the ILC.

## 3.1.5 (Deleted)

## 3.1.6 (Deleted)

## 3.1.7 (Deleted)

3.1.8 (C) The launch vehicle shall have the following reliability:

- a. Launch-on-time (this requirement assumes the core and SRMs are integrated and on the pad ready for checkout, but does not include weather or range constraints). .87
- b. Lift-off through orbital insert with transtage .93
- c. Launch through orbital insert without transtage .97

3.1.9 (C) The launch vehicle shall have hold capabilities consistent with Titan III as specified in SSD Exhibit 62-126.

3.1.10 (C) The launch vehicle shall be capable of launching within a pre-selected 4 minute launch window.

3.1.11 (U) The launch vehicle shall have sufficient strength, stiffness and control capability to sustain the loads and environment experienced during on-pad, ascent, and on-orbit requirements. It shall meet SSD approved wind requirements (ground and winds aloft).

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3.1.12 (U) Ascent shall be shaped such that the Gemini abort constraints, launch vehicle and payload heating, and loads constraints are not violated.

3.1.13 (C) The launch vehicle shall have the capability to insert the payload into orbit within 3 sigma Titan III accuracies (Ref: Preliminary Performance/Design Requirements for the Manned Orbiting Laboratory System, General Specification for, dated 1 July 1965, para 3.3.6.1.2). (Any Stage II redesign required to achieve these accuracies shall be subject to separate contractual action.)

3.1.14 (C) The transtage of the vehicle shall be capable of maintaining attitude control of the entire orbiting vehicle (including the payload) while still attached. It shall be capable of being detached from the payload on command from the payload without imparting more than 1.0 degree/sec in pitch, yaw or roll to the payload.

3.1.15 (U) The configuration without transtage shall include Stage II retro-rockets.

3.1.16 (Deleted)

3.2 (U) Payload - Six payload configurations corresponding to six flight vehicle configurations shall be defined by SSD/Aerospace for the Titan III/MOL launch vehicle in terms of length, weight, center of gravity location, diameter, and stiffness.

3.3 (U) Aerospace Ground Equipment (AGE) - MOL/Gemini B peculiar AGE criteria shall be provided to the ILC program from this contract. AGE design requirements for MOL/Gemini B shall be identified under the ILC program. The laboratory vehicle contractor, and the Gemini B vehicle contractor will supply and operate their respective vehicle AGE.

## 3.4 Facility

3.4.1 (U) Facility design criteria studies to make the ITL at ETR compatible with MOL-EFT are being conducted as part of the MOL-EFT contract. Facility design criteria studies to make the ILC/ITL at WTR compatible with MOL and large solid rocket motors are being conducted as part of the WTR FCEI contract. These criteria will be utilized in the preparation of data and documentation for this contract.

3.4.2 (U) Facility items that affect system reliability and the on-time launch capability will be identified by the contractor and given reliability requirements as soon as practicable.

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#### 4. MODIFICATION CRITERIA

4.1 (U) Launch Vehicle Configuration - The reference configuration for the TIII/MOL Booster shall be that established on SLV #11 in the 624A Program, minus the SLV #11 mission peculiar modifications. Mission peculiar configuration changes for the MOL mission shall be incorporated by ECP. Engineering and design effort for the preparation of the ECPs shall be governed by Part I to the Vehicle CEI Specification. Fabrication and acceptance of the modified Vehicle shall be in accordance with Part II of the Vehicle CEI Specification.

4.2 (U) Launch Vehicle Modifications - Each modification to the vehicle described in 4.1 shall be identified and defined in terms of crew safety, mission success, and improved performance. Modifications to be considered shall include, but not be limited to those specified in Table 2. Definition of the modifications and studies to be performed in support thereof is set forth in 5. below.

4.3 (U) Production, Operations, and Test Plans - Production, operations, and test plans will assume that each present associate Titan III launch vehicle contractor will produce, operate and test the present and/or modified system as is now being accomplished in the Titan III R&D program. The contractor will assume he is to be the launch integrating contractor for the MOL System.

Table 2 Launch Vehicle Modifications To Be Considered

| Segment  | Crew<br>Safety | Mission<br>Success | Improved<br>Performance |
|--|----------------|--------------------|-------------------------|
| <u>Stage 0</u>   |                |                    |                         |
| 1. 7-Segment 120-inch SRMs   |                |                    | X                       |
| 2. TVC mods  |                |                    |                         |
| a. Second power supply for pitch and yaw control   | X              | X                  |                         |
| b. Second battery  | X              | X                  |                         |
| c. Two independent hydraulic power supplies and manifolds  | X              | X                  |                         |
| 3. Delta pressure sensors for use with MDS   | X              |                    |                         |
| 4. 156-inch SRMs (WTR only)  |                |                    | X                       |
| <u>Stage I</u>   |                |                    |                         |
| 1. Redundant turbine-driven hyd pumps  |                | X                  |                         |
| 2. Redundant hyd power supplies and redundant servo actuators or servo valves w/double seal actuators together w/transfer valves |                | X                  |                         |
| 3. 15:1 expansion nozzle   |                |                    | X                       |
| 4. Dynamically stable injector   | X              |                    |                         |
| <u>Stage II</u>  |                |                    |                         |
| 1. GEMSIP stable injector  |                | X                  |                         |
| 2. Hydraulics  |                |                    |                         |
| a. Redundant power supplies  |                | X                  |                         |
| b. Redundant servo valves (with transfer valves)   |                | X                  |                         |
| c. Tandem or dual seal actuators   |                | X                  |                         |
| <u>Stage III</u>   |                |                    |                         |
| 1. Hydraulics  |                |                    |                         |
| a. Redundant power supplies  | X              | X                  |                         |
| b. Redundant servo valves (with transfer valves)   | X              | X                  |                         |
| c. Tandem or dual seal actuators   | X              | X                  |                         |
| 2. Redundant payload separation  |                | X                  |                         |
| 3. Improved electrical sequencing sys  | X              | X                  |                         |
| 4. Deletion of transtage propulsion  |                |                    | X                       |
| <u>Guidance and Control</u>  |                |                    |                         |
| 1. Gemini IGS back-up  | X              | X                  |                         |
| 2. Redundant flight controls system and static inverter  | X              | X                  |                         |
| <u>All Stages</u>  |                |                    |                         |
| 1. Improved fittings   |                | X                  |                         |
| 2. High-reliability parts  | X              | X                  |                         |

5. (U) CONTRACTOR TASKS

The contractor shall perform the following tasks and subtasks in two increments in fulfilling the requirements of this program plan. The first increment shall consist of performing applicable tasks and trade offs of cost, schedule and performance to a level of detail sufficient to identify a recommended Titan III/MOL booster vehicle configuration by 31 August 1965. This evaluation shall consider the vehicle configurations identified in 3.1.1. The crew safety and mission success modifications will be considered in the evaluation of each of these vehicle configurations. The second increment of the contractor's study effort shall consist of performing the tasks for the vehicle configuration approved by SSD, to a level of detail sufficient to optimize the booster and launch system and establish design criteria which will result in ECPs and contract end item (CEI) specifications in accordance with 4.1.

5.1 Program Management and Control

5.1.1 (U) Internal Procedures and Schedules - The contractor shall establish internal procedures and schedules for the purpose of maintaining control of the study activities to be accomplished. Procedures shall include regularly scheduled internal status meetings, liaison with associate contractors, and meetings with SSD/Aerospace.

5.1.2 (U) Associate Contractor Data - Minimum requirements and need dates for associate contractor data will be identified in the Martin Interface Schedule. The contractor shall be prepared to support other associate contractor needs in their study efforts by providing needed data.

5.2 (U) Systems Engineering - The studies and analyses defined in this program plan and to be performed by the contractor shall generally comply with AFSCM 375-5 dated 14 December 1964 in terms of procedures and documentation to the extent specified in Annex A hereto. Standardization of system engineering data shall be defined in the contractor prepared TIII/MOL System Engineering Implementation Plan. The systems engineering data called for in subsequent paragraphs of the contractor's tasks shall consist of the following elements:

- a. Receipt through launch flow diagrams, timelines, functional requirements data and schematics developed as part of the ILC program.
- b. Launch vehicle flight mission through orbit inject and payload separation flow diagrams, functional requirements data and schematics developed as a part of this contract.

5.2.1 (U) Applicable Requirements and Source Documentation - The contractor shall identify the requirements and source documentation applicable to the system under consideration. These data will be documented as a part of the requirements plan (Form Bs) in the systems engineering documentation.

5.2.1.1 (U) Mass Properties

- a. The contractor shall establish the mass properties for the Titan III/MOL launch vehicle configurations by:
  - 1) Estimate weight and balance of changes under consideration.
  - 2) Conduct trade-off studies involving system weight.
  - 3) Study payload weight and related design factors, C.G. location, length, etc.
  - 4) Conduct liaison with associates providing data exchange.
- b. System weight and balance reports shall be updated as necessary to provide current performance to the Air Force and associate contractors.

5.2.2 (U) Develop Detailed Operations Functions - The contractor shall modify existing Titan III function flow diagrams, or create new diagrams as necessary to cover revised or new functions required for the Titan III/MOL. These detailed operational functional diagrams shall depict graphically and sequentially the detailed functions which must be satisfied to meet the Titan III/MOL booster system requirements. The diagrams shall reflect all operations from receipt through orbit inject and payload separation for the MOL missions. Interface requirements for all AVE to ground equipment shall be identified for the selected vehicle configuration under the ILC/WTR contract. All system planning shall be based on the MOL top system flow diagram. These diagrams shall be expanded as necessary to add the functions resulting from Gemini B, Laboratory, Experiments, and other associate contractor operations. This effort shall consist of development of integrated lower indenture functional flows from the top flow diagram referenced above. The contractor shall analyze and integrate booster and payload expanded level flow diagrams. The contractor shall develop, from booster and payload associate contractors' timeline data, an integrated timeline for launch critical functions. The documentation of these flow diagrams and timelines as part of the supporting engineering data for contractor tasks shall be in general accordance with AFSCM 375-5 as defined in Annex A hereto.

5.2.2.1 (U) Personnel Equipment Data (PED) and Test Procedures - A planning, scoping, and identification effort shall be accomplished in conjunction with the studies required in 5.2.2 and 5.2.3 to enable preparation of PED and test procedures in accordance with SSD-CR-64-180, Appendix C. This activity shall result in an index type document which identifies and scopes the PED tasks and test procedures to be prepared subsequent to SSD approval of ECPs and/or CEI specifications, as applicable. In support of procedural and personnel analyses for the systems functional analysis, trade-off studies and flow diagram change preparation, the contractor shall revise PED integration criteria and test procedure preparation criteria to incorporate changes imposed by associate contractor and contractor operations functions.

5.2.2.1.1 (U) Test Procedures - The contractor shall provide a list of existing test procedures requiring revision, and a list of new procedures to be prepared in addition to the effort described in 5.2.2.1 above. After SSD approval of ECPs/CEI Specifications, this list shall be updated.

5.2.2.2 (U) Launch Vehicle Systems Engineering Data Integration - As part of the systems compatibility analysis effort, the contractor shall integrate the systems engineering data provided by booster associate contractors with the data developed by the contractor (see 5.2.2) in the performance of the tasks of this program plan. These data shall consist of top flow diagrams, expanded first level flow diagrams, time-function analysis data for launch critical functions, function requirements data and schematics. The content and format of these data shall be consistent with that provided under SSD Exhibit 62-169 of the Titan III program. These data shall fulfill the general requirements of AFSCM 375-5 to the extent identified in Annex A hereto. All system engineering data submitted under this contract, including applicable existing Titan III data, shall be numbered in accordance with the MOL System Top Level Functional Flow Diagram.

5.2.2.3 (U) MOL System Associate Contractor Requirements Analysis - The contractor shall review MOL System associate contractor's pre-orbit technical requirements and test plans to assure their compatibility with each other and with the TIII/ILC System. This effort shall include a review to incorporate MOL system functions into the receipt through orbit inject sequence as required in 5.2.2. A review of MOL system requirements data shall also be performed as part of the effort in performing the contractor tasks of this program plan. The MOL systems requirements data shall be provided to the contractor in documentation as required by AFSCM 375-5. These data shall be integrated into the contractor's system engineering documentation to the extent called for below:

- a. Flow Diagrams and Timelines - as required in 5.2.2.
- b. Function Requirements Data - interface data only will be integrated into the contractor's documentation.



5.2.2.3 (Continued)

- c. Function Schematics - schematics shall be integrated to the first and second level as defined by AFSCM 375-5.

The contractor shall review associate contractor test plans, supplied by SSD, for compatibility with the overall system. These test plans, defining one time compatibility or special marriage tests, shall be incorporated into the TIII/MOL Addendum to the Engineering Test Program Plan. MOL system associate contractor pre-orbit technical requirements shall be reviewed for effect on AGE operation and hardware.

5.2.3 (U) Develop Performance/Design Requirements for Operational Functions - The contractor shall develop performance/ design requirements for new or revised equipment to perform the Titan III/MOL mission. This shall include receipt at ILC through orbit inject and payload separation. The contractor shall document the results of the above analysis as addenda to Titan III systems engineering data defined in Annex A hereto. Major emphasis shall be placed on quantification of operations functions in performance terms. This effort shall primarily be an extension of the effort conducted in the Pre-phase I Study under Contract AF O4(695)-604. Additional criteria effort shall include the following:

5.2.3.1 Cockpit Displays

5.2.3.1.1 (U) Booster-Generated Gemini B Displays - Establish design criteria for booster-generated Gemini B cockpit displays for malfunctions requiring crew escape, or switchover to redundant devices, incorporating the requirements of associate contractors.

5.2.3.1.2 (Deleted)

5.2.3.2 (U) Environmental Criteria - The contractor shall establish the launch vehicle environmental design criteria for the pre-launch, launch, ascent, and orbit inject and payload separation for the MOL mission. The contractor shall modify or expand SSD Exhibit 62-166A, entitled Environmental Criteria, dated July 1964, by incorporating Titan III R&D flight test data and contractor analyses. Determine a wind criteria applicable to the MOL mission with mean and probability distribution. Determine the effect of reducing wind criteria on payload constraints. The result shall be presented in terms of per cent of Program 624A winds and in terms of launch probability.

5.2.3.3 (U) Failure Environmental Model Criteria - The contractor shall establish the failure environmental model criteria for on-pad and ascent phase through orbit inject and payload separation. These criteria shall be based on the Pre-Phase I Crew Safety analyses, updated to define the environments of the launch vehicle configurations. The explosion pressure field will define overpressure, total impulse, and pulse duration of blast waves as functions of distance from the explosion and altitude at the time of explosion. The thermal environment shall be defined as a function of altitude in terms of radiant heat flux at several distances and angles from the fireball or engine exhaust plumes. A fragmentation model will be presented which defines typical fragment sizes and velocities. Toxic and acoustic environment for launch pad aborts will be defined.

5.2.3.4 (U) Reliability Data Criteria for Launch Vehicle - Immediately after go-ahead, the associate contractors, MMC and SSD/Aerospace personnel will meet to discuss a proposed criteria for data interchange affecting the following:

- a. Failure Mode and Effect Tabulation (See 5.2.6.23.1)
- b. Launch-On-Time Probability Studies (See 5.2.6.24)
- c. Malfunction Detection Methods (See 5.2.6.23.7)

From this meeting a formal mission success and crew safety data criteria will be established which will be integrated by the contractor and issued to the associates and SSD/Aerospace. This criteria will be updated during the performance of this study on an as-required basis.

5.2.3.5 (Deleted - effort to be performed under 5.2.3.6)

5.2.3.6 (U) Performance/Design Data For Titan III/MOL Modifications - New or revised performance/design data shall be developed for airborne equipment for incorporating the various modifications into the Titan III/MOL. The modification shall include, but not be limited to the following major items:

- a. A Stage I Engine of 15:1 Expansion Ratio - The contractor shall incorporate engine data supplied by the associate contractor. The impact of this modification on airborne equipment, AVE performance, and overall schedule impact shall be the responsibility of the contractor. Included in this effort shall be:
  - 1) A flight controls analysis of effects on actuators and hydraulics and coupling of engine modes with structural modes.
  - 2) An evaluation of airborne structural modifications resulting from the expansion ratio change, i.e., clearances, effect on associate envelopes, Stage I longeron, etc.

5.2.3.6.a (Continued)

- 3) Evaluation of changes to refrasil blanket and TCA closures.
- b. A Stage 0 Incorporating 7-Segment and 156-Inch SRM - Provide support to SSD/Aerospace and Titan III associate contractors in the establishment of a design criteria for a Titan III/MOL booster utilizing a seven-segment and 156 inch SRM Stage 0. Studies shall include, but not be limited to the following:
  - 1) Determine requalification or redesign requirements for all booster components for the environment defined.
  - 2) Determine to the extent possible by analysis the effect on the transtage antennas of the products of SRM staging rocket exhaust.
  - 3) Investigate analytically the effects of the SRM on the antenna patterns.
  - 4) (Deleted)
  - 5) Determine relocation, if required, of any components because of higher vibration levels.
  - 6) Determine restrictions on SRM TVC performance for compatibility with the guidance and flight control systems.
  - 7) Determine and analyze new attach point and study associated stresses.
  - 8) Determine effect on cockpit display of SRM changes (including differential pressure sensor) including:
    - a) Interface requirements with solid motor contractors for new location of SRM Core Staging Cable assemblies.
    - b) Preliminary airborne interface specifications.
  - 9) The contractor shall integrate associate contractor inputs and provide integrated systems engineering data. The contractor shall also prepare layouts of the SRM attachment hardware and the structural modifications required to the core. The contractor shall evaluate equipment mounting changes, clearances, physical attachments, cable fairings, Stage II forward oxidizer skirt, etc. The contractor shall determine the thrust-time curves including tailoff for the 7-segment and 156-inch solid rocket motors that will yield the optimum payload capability and satisfy the overall vehicle constraints:

5.2.3.6.b.9 (Continued)

- a) Maximum dynamic pressure,
  - b)  $q \propto$  staging,
  - c) Aerodynamic heating indicator,
  - d) Acceleration profile,
  - e) Other environments,
  - f) Unsymmetrical SRM web burnout,
  - g) Stage I engine NPSH constraints.
- 10) Thrust termination studies including associated TVC characteristics after thrust termination.
- 11) Stage I engine NPSH studies shall include effects of propellant and pressurization changes wherein full duration pressurization profile and requirements are predicted.
- c. Base heating as altered by the SRM shall be investigated by the contractor utilizing the support of the associate contractors. The changes required to the boattail and associated insulation as a result of the base heating changes shall be evaluated.
- d. Brazed and welded fittings shall be utilized to the maximum extent feasible in the hydraulics as well as the pressurization system. Where disconnect capability must be retained for maintenance or repair, fittings of improved design shall be provided. Methods of joining tubing by brazing or welding will be studied. This will include evaluation of processing methods, feasibility tests and preliminary development of design criteria.
- e. (Deleted)
- f. Study the effect of SRM installation and operation on thermal control coatings on the airborne vehicle.

5.2.3.6.1 (U) Analysis of Structural Loads - The contractor shall perform an analysis of structural loads on selected payloads. This shall include the MOL interface and all vehicle structures affected by modifications. The structure of the core shall be analyzed using trajectory information as an input including all thrust loads, maneuvering loads and aerodynamic loads. Staging and thrust termination loads shall be determined. The contractor shall perform certain tests that are necessary to verify selected performance/design parameters. These tests shall include wind tunnel (including buffet) tests as deemed necessary. Implementation of wind tunnel tests shall be subject to separate contractual action.

5.2.4 (U) SPO System Requirements Reviews and Technical Direction - The contractor shall be prepared to support a system requirements review and technical direction meeting during the late phases of effort under subtasks 5.2.2 and 5.2.3 above. During these reviews the contractor will be required to provide the supporting system engineering documentation. Specific attention will be directed toward a review of interface documentation between related contractors to insure that system compatibility is being maintained.

5.2.4.1 (U) On 31 August 1965, the contractor shall conduct a review and briefing of his evaluation of potential TIII/MOL booster configurations and shall present his recommendations for the final configuration on which to base the remaining study effort. This recommendation shall be supported by trade-off studies on configuration design, cost, schedule, and performance.

5.2.5 (U) Trade-Off Studies of Operational Elements of the System - Trade studies shall be accomplished to provide the technical rationale for determining performance/design requirements for operational end items, facilities, and requirements for test operation personnel and training. Problems that were not resolved in Pre-Phase I shall be studied. In addition, trade studies specified below which involve major and critical decisions for program implementation will be performed. The decisions resulting from trade studies shall be documented in systems engineering data defined in Annex A hereto. Trade study results shall be examined to determine feedback changes to operation functions, design requirements for the operation functions, and to the effected specifications. The trade studies shall be repeatedly maintained or expanded as necessary to support system development. Trade studies shall include, but not be limited to:

- a. Vehicle integration procedures as part of the task of integrating MOL and booster associate contractor functions in flow diagrams, trade studies, as required, will be performed to optimize function sequencing.

5.2.5 (Continued)

b. Change of antenna or antenna location including:

- 1) Scale model drawing preparation and coordination with manufacturing and checkout at antenna range.
- 2) Antenna model tests for the 7-segment configuration and for 156-inch configuration if necessary.
- 3) Preliminary RF configuration for the configuration description document.
- 4) Evaluation of the antenna model tests to determine the final RF configuration.
- 5) Evaluation of structural modifications required for revised antenna or antenna location.

c. Results of the ILC study concerning an integrated CST (i.e., MOL plus launch vehicle integrated countdown/simulated flight) versus separate CST (i.e., normal, launch vehicle CST and a separate flight simulation for the orbital vehicle) shall be included in the TIII/MOL study report.

d. (Deleted)

e. Early installation of ordnance items before Gemini B/laboratory vehicle mating (due to inaccessibility) versus on-pad installation.

f. (Deleted)

g. (Deleted)

h. Hi-Rel piece parts program. Trade-off studies will be performed to determine the need and scope of utilizing Hi-Rel electronic piece parts in selected applications. A Hi-Rel piece parts program will be prepared, based on the proposed configuration.

i. Launch vehicle performance with SRM design as reported in Pre-Phase I studies versus modified SRM designs with altered thrust-time characteristics.

j. Special studies at the request of the procuring activity will be required during the course of this effort, and will be subject to separate contractual action.

5.2.5 (Continued)

k. (Deleted)

1. A 3 dimensional soft mock-up of the transtage shall be used to determine accessibility, maintainability, location of work platforms, work space needs, and relocation of vehicle and AGE equipment.

5.2.6 (U) Develop Design Requirements for Operational End Items - Design requirements shall be developed for operational end items by conducting studies and analyses to relate functional requirements to equipment. The results of these studies shall be incorporated directly or by reference in systems engineering data. These studies shall include, but not be limited to the following:

5.2.6.1 (U) Aerodynamic Coefficients-Payload - Derive aerodynamic coefficients for the selected payload configurations.

5.2.6.2 (U) Aerodynamic Coefficients-Staging - Determine the aerodynamic coefficients for the staging analysis of Stage 0 - Stage I separation for the selected payload configurations.

5.2.6.3 (U) Trajectory Shaping - Stage 0 - Shape Stage 0 trajectory for loads and performance for the selected payload configurations and boosters as called out in 5.2.6.10 and within heating and abort constraints to determine the optimum Stage 0 attitude history to decrease the loads or increase the performance.

5.2.6.4 (U) Staging Boundaries and Dispersions - Evaluate all staging regimes and determine staging boundaries and dispersions for the selected payload configurations. Staging studies shall include all significant factors such as venting, ignition over-pressure, staging rocket requirements, NPSH, and structural loads. Use shall be made of the propellant feed model and the Stage I engine model. Evaluate the effect of 15:1 on SRM separation clearance and TCA cover ejection requirements, also, a staging sequence of events will be established.

5.2.6.5 (U) Launch Vehicle Aerodynamic Heating - Determine the launch vehicle aerodynamic heating associated with the boost trajectory for the selected payload configurations and boosters as called out in 5.2.6.10.

5.2.6.6 (U) Distributed Air Loads - Determine distributed airloads at  $M = .8, .9, 1.0, 1.1, 1.2, 1.4, 1.55, 2.0, 2.5$  and  $3.5$  for the selected payload configurations.

5.2.6.7 (U) Launch Clearance - Contributions of the airborne systems to the launch drift envelope will be determined. Review launch clearance parameters with respect to Flight Control System effects to determine checkout tolerance requirements.

5.2.6.8 (U) Stage 0 Elastic Loads - Perform preliminary Stage 0 Load Analyses including effects of dispersions, gust, buffet and elasticity on two P/L configurations and estimate loads for a third P/L configuration. Effects of gust will be estimated. Effect of buffet will be estimated and updated using results of buffet test if available in time. Meteorological Note No. 2 shall be used for wind aloft studies.

5.2.6.9 (U) Structural Loads - Perform detailed analyses of structural loads at Gemini B/Laboratory Vehicle and MOL/Transtage interfaces for launch vehicle/payload configurations 1 (I<sub>S</sub>), 3 (II<sub>S</sub>), and 5 (III<sub>S</sub>) identified in 3.1.1. Establish the permissible length of payload that can be carried by the above launch vehicles, within the strength capability of the core structure. The validity of the bending data for the no transtage case shall be confirmed by a mode shape and frequency comparison. In conjunction with the above effort, the loads will be determined at five payload stations.

5.2.6.10 (U) Reference Trajectories - Establish reference trajectories for both the basic configuration and alternatives to the basic configuration. These trajectories shall be used as a reference point for preliminary use by other using groups, such as structure, propulsion, electronics, guidance and aerodynamics. Three degrees of freedom guidance reference trajectories shall be generated for configurations 1, 2, 5 and 6 for both Mission 1 and Mission 4. Configurations and missions are as described in 5.2.6.22. For configurations that include the transtage, an orbit altitude of 130 nautical miles shall be used. (Inject into 80 nautical mile, overspeed, circularize at 130 nautical miles.) For vehicles that do not use a transtage, the orbit altitude shall be 80 nautical miles.

5.2.6.11 (U) TVC Fluid Requirements - Perform studies of TVC system fluid requirements to determine vehicle performance with optimum fluid loading for selected payload configurations and trajectories as called out in 5.2.6.10. As part of these studies, the TVC math model (1620) shall be used to determine injectant flows to various command voltages as a function of chamber pressures. The results will be used to determine loading requirements.

5.2.6.12 (U) Pre-Flight Loads - Perform pre-flight loads analyses for the selected payload configurations (See 3.2).

5.2.6.13 (U) Stability Analysis - Perform a stability analysis for axial oscillations (longitudinal vibration analysis) using the three selected payload configurations.



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5.2.6.14 (U) Autopilot Constants - Stages O, I, and II - Establish autopilot constants for Stages O, I, and II based on linear elastic analysis and available loads analysis in order to satisfy the requirements of SSS-TIII-OIO SLV. Determine natural frequencies, modal displacements and slopes at critical stations for 3 payloads and several flight times during Stages O, I, and II flight. Critical stations shall be identified during the loads and vibrations studies. The analyses will consider pitch-roll and yaw-longitudinal coupling. Evaluate possible changes to ground checkout equipment for this and the following two paragraphs.

5.2.6.15 (U) Autopilot Constants - Stage III - Establish autopilot constants for Stage III powered flight based on linear and non-linear analyses. Determine natural frequencies, modal displacements and slopes at critical stations for selected payloads and several flight times. The analyses will consider pitch-roll and yaw-longitudinal coupling.

5.2.6.16 (U) Autopilot Constants - Coast Phase - Establish autopilot constants for the coast phase for selected payload configurations.

5.2.6.17 (U) Fuel Slosh Stability Effects - Establish the effect of fuel slosh on control system stability. Selected time points (determined by past Titan III studies and the analyses of 5.2.6.14 and 5.2.6.15 above) will be analyzed by both digital and analog simulation to assure that the effects of fuel slosh are acceptable throughout flight.

5.2.6.18 (U) Guidance System Stability Effects - Determine the effects of both guidance systems on stability. The effect on the booster control system of quantization, computational delays, and other nonlinearities in the ACED and Gemini inertial guidance systems will be specified where applicable.

5.2.6.19 (U) Staging Control Authority - Control authority analysis will be performed in conjunction with tasks 5.2.6.4, 5.2.6.14, and 5.2.6.15.

5.2.6.20 (U) Control System Performance Tolerance - Perform control system performance tolerance studies for Stages O, I, II, and III for three payloads, using SRMs in the presence of 3 sigma tolerance variations of system parameters to assure that the system is stable under these conditions. Airborne data from this study will be used to determine tolerance requirements for FCS checkout.

5.2.6.21 (Deleted)

5.2.6.22 (C) Payload Capability - Determine circular orbit payload capability of launch vehicle configurations with Titan III/MOL modifications. A payload altitude profile will be generated for configurations

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## 5.2.6.22 (Continued)

1, 2, 5, and 6 and Mission 1. For Missions 2, 3, and 4, the payload shall be determined for 80 nautical miles. For configurations which include the transtage, an optimum transtage propellant load will be utilized. Launch vehicle instrumentation and telemetry weights shall be equivalent to the R&D configuration. The optimum thrust-time histories that were generated in 5.2.5.1 will be used for these studies.

| <u>Launch Vehicle Configurations</u> | <u>Missions</u> |
|--------------------------------------|-----------------|
| 1 (I <sub>S</sub> )                  | 1,2,3,4         |
| 2 (I <sub>L</sub> )                  | 1,2,3           |
| 3 (II <sub>S</sub> )                 | 1               |
| 4 (II <sub>L</sub> )                 | 1               |
| 5 (III <sub>S</sub> )                | 1,2,3           |
| 6 (III <sub>L</sub> )                | 1,2,3,4         |

- a. Mission 1 - South launch from WTR to obtain orbit inclination of 90 degrees.
- b. Mission 2 - South launch from WTR to obtain orbit inclination of 80 degrees without dogleg maneuver.
- c. Mission 3 - South launch from WTR to obtain orbit inclination of 97 degrees without dogleg maneuver.
- d. Mission 4 - South launch from WTR with a dogleg maneuver to obtain an inclination angle of 60 degrees. The trajectory studies will also be used to determine the magnitude of the yaw steering commands and the time of initiation of yaw steering that will yield optimum payload capability.

5.2.6.22.1 (Deleted)

5.2.6.22.2 (Deleted)

5.2.6.22.3 (C) Maximum Payload Length - Determine the maximum 10.5 foot diameter payload length which can be launched into MOL orbits observing both booster and payload constraints, including wind criteria. If payload lengths up to 70 feet in length with transtage, and up to 82 feet without transtage cannot be attained, reduction in wind criteria may be considered to achieve these lengths, and a Stage 0 flight load analysis with reduced wind criteria performed. Alternately, modifications to

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## 5.2.6.22.3 (Continued)

the core vehicle necessary to meet the full wind criteria and maximum payload lengths will be determined. Buffet, gust, and dispersion effect will be estimated and included in the analysis. The contractor shall establish the flight control system configuration for maximum length MOL for a 7-segment and 156-inch SRM.

5.2.6.23 (U) Malfunction and Redundancy Study - This study shall result in designs of Titan III guidance and control system modifications to increase crew safety by provision of redundancy and modifications to increase mission success. It shall be an objective of the crew safety modifications to increase failure warning time and to increase mission reliability. This study shall also result in computerized techniques for continuing studies, such as development of an analog computer program to investigate non-linearities and increase flexibility of future crew safety studies.

5.2.6.23.1 (U) Failure Mode Tabulation for System Level - The contractor will accomplish this task in accordance with the functional flow diagram in Fig. 1. Because of the time element in the study, the following ground rules are established:

- a. This task will be initially oriented toward the current configuration; however, the recommended configuration will be analyzed as sufficient data becomes available.
  - b. The math model which is incorporated in the electronic data processing program will be oriented to probability of mission failure as a result of single malfunctions. Some double malfunction analyses will be completed manually.
  - c. Failure rates and, consequently, probability of failure will be estimated based on "achieved" numbers. The achieved failure rates will not be broken down into inherent and practice failure rates.
- 1) Reliability Studies and Analysis - Existing reliability studies performed by the contractor and associate contractors will form the basis for the failure mode tabulation study. The existing studies will be updated to reflect the best information currently available. The contractor's reliability studies completed during the Titan III program are broken down as follows:
- a) Electronic - Electrical Components - Reliability studies are based on piece part failure rate data in accordance with M-63-3, entitled Engineering Reliability Policy and Procedures Manual, biased by applicable test data.

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5.2.6.23.1.c.1 (Continued)

- b) Mechanical - Elector Mechanical Components - Reliability studies are based on safety factor analysis and piece part failure rate data where available. the information in these studies will be reworked to provide a more detailed description of failure modes versus time, and to reflect any changes of failure rates because of new knowledge or test data. Associate contractors will be requested to modify and update their reliability studies in a similar manner and to provide the Martin Company this data, presented in a format to be agreed upon per 5.2.3.4.a.
- 2) Failure Mode and Effect Analysis - Utilizing the information available from the reliability studies, a detailed analysis will be made for each significant failure mode of each reliability-sensitive "black box" to determine additional information which includes, but is not restricted to the following:
- a) Failure rate per failure mode;
  - b)  $K_{op}$  (Environmental operating factor);
  - c) Lead-time analysis requirements;
  - d) Switch-over analysis requirements;
  - e) Motion tape requirements;
  - f) Effect on vehicle (prior to switching action);
  - g) Malfunction detection method;
  - h) Required action after malfunction;
  - i) Applicable abort environment.

The analysis will show the variation in the above items with flight time. Associate contractors will assist in this analysis by providing the Martin Company with information peculiar to their hardware (see 5.2.3.4). From airborne failure mode studies, determine necessary checkout requirements to improve mission success probability.

- 3) Failure Mode/Failure Effect Data Handling - (See 5.2.6.23.3)
- 4) Reports - The contractor will prepare and submit a final report at the end of this study to the extent compatible with hardware design status:

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## 5.2.6.23.1.c.4 (Continued)

- a) Summarizes significant parameters such as net probability of failure for each mission effect.
- b) Indicates the ability of the MDS to sense each failure or its effect.
- c) Establishes the resulting effect on crew safety attributable to failures in terms of warning time between detection of the failure and its catastrophic results.

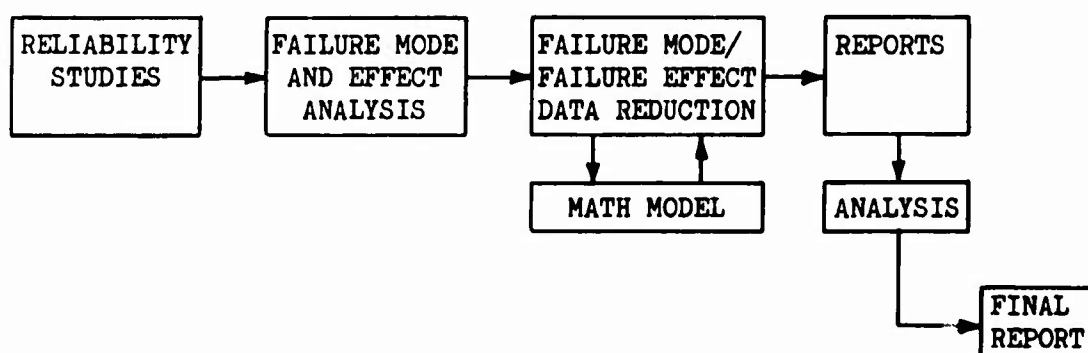


Fig. 1 Failure Mode Tabulation Functional Flow

5.2.6.23.2 (C) Malfunction Effect Model and Simulation - Model simulation to determine vehicle motion and loads as a result of each class of system failure modes, shall be handled in three parts. An elastic body analogue computer model shall be developed to investigate non-linear effects and increase flexibility of future analysis. A six degree-of-freedom digital rigid body trajectory program shall be modified as necessary to give rigid body motion up to 10 seconds after the malfunction or until ultimate loads are exceeded. The simulation shall be capable of obtaining warning times as a function of time of flight. This model will also be used to investigate slow divergent malfunctions. A generalized elastic digital model including pitch-roll coupling effects (quasi-steady state) shall be constructed using existing techniques to investigate loads and dynamic response induced by malfunction and switch over transients. All of the structurally critical launch vehicle stations shall be identified. Estimates of all sources of loads including flexible body loads, combined statistically, shall be determined for these stations. The above models shall define the motion and load for the failure modes identified by 5.2.6.23.1 at critical flight times for nominal and dispersed conditions. A 25,000 lb, 10 foot diameter, 50 foot long laboratory and capsule (configuration 32 of the MOL Pre-Phase I Study) shall be used as the dynamic model for crew safety modifications until data becomes available for the larger boosters. For crew safety dynamic analysis subsequent to 31 August 1965, the selected booster configuration and one payload configuration will be used.

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5.2.6.23.3 (U) Failure Mode/Failure Effect Data Reduction - An electronic data processing program will be developed during Phase I for storing and retrieving data elements specified in 5.2.6.23.1. This program will also incorporate the mode model referenced in 5.2.6.23.1 and will be developed with the following objectives:

- a. Maximum flexibility in retrieval of data;
- b. Minimum coded output;
- c. Minimum effort to make any future program modifications.

5.2.6.23.4 (U) Motion Tapes - Motion tapes, comprised of approximately 60 malfunctions runs, shall be generated using the six degree-of-freedom rigid body trajectory simulation. These tapes shall be compatible with the Gemini B contractor requirements and supplied along with the times at which ultimate structural loads are exceeded.

5.2.6.23.5 (U) Guidance and Flight Control System Configuration - The contractor shall establish with ACED and UTC, a guidance and flight control system configuration which achieves the reliability and crew safety requirements for the Titan III/MOL mission. The contractor shall supply ACED and the Gemini B contractor with backup guidance system requirements to permit evaluation and design of the Gemini B inertial guidance system or booster guidance for this function. Alternative approaches to the flight control system configuration which will be developed for evaluation by the contractor include:

- a. Redundant Titan III adapter-programmers and computers;
- b. Redundant improved autopilot (based on a stage dependent design utilizing field effect transistors);
- c. Redundant digital autopilot techniques;
- d. Dual and majority vote sensor configurations;
- e. Simplified sensor configurations;
- f. Hydraulic systems: GLV type, electrical feed-back type;
- g. Redundant hydraulic power sources and valves with a single piston;
- h. Discrete signal generation methods will be developed which will include majority voting for critical signals, dual redundancy for less critical discretely, and use of the digital flight control computer;
- i. Triple redundant autopilot.

5.2.6.23.5 (Continued)

Malfunction sensing techniques, switching methods, and switching points (within the flight control system) will be developed in conjunction with the malfunction effect simulation analysis (5.2.6.23.2). Criteria for switching the guidance systems will be established in conjunction with ACED. Analyses for redundant guidance shall include the following:

- a. Obtain characteristics of backup system from MAC in terms of:
  - 1) IMU characteristics;
  - 2) ADC (storage, sampling, etc.).
- b. Obtain data from MAC and ACED, and perform error analysis as necessary on each system to define nominal deviations from IMUs and navigation equations.
- c. Work with Aerospace, ACED, and MAC to establish a set of guidance and navigation equations which are compatible with both systems. These equations will reflect optimum performance for the widest trajectory deviation.
- d. Establish criteria for detecting slow malfunctions in terms of trajectory deviations which will enable switch-over in time to successfully complete the mission.
- e. Provide data for switch-over analysis which will define behavior of backup system after switching as it will affect trajectory, limit cycles, load transients and need for transition steering command logic circuits.

This analysis will be performed for vehicle configurations which are consistent with the analysis described in 5.2.6.23.2. Analysis of these redundant systems shall include the following electrical effort:

- a. Determine power system modifications required due to changes in the guidance or control system. This will include evaluation of existing inverter and battery capabilities and determine modifications or new equipment needed for the study in 5.2.6.23.6.a.2).
- b. Determine effects on airborne sequencing system to the extent necessary to define method of implementation. This will include definition of basic logic and evaluation of switching methods.
- c. Provide inputs to and support coordination of design with affected associates. Defining as required, power characteristics, methods of switching, cabling, connector interfaces, etc., for specification preparation.

5.2.6.23.6 Design Evaluation of Redundant Configurations

- a. Design of Redundant Systems - The contractor shall act as a systems integrating contractor for design of redundant systems. The contractor or associate responsible for each subsystem shall propose design modifications, and evaluate these changes in terms of their effect on subsystem reliability, and effect on failure modes and associated probabilities of occurrence. The systems integrating contractor shall evaluate the proposed modifications in terms of impact of the change on total vehicle reliability. The studies for this effort shall include:
  - 1) Study of vehicle sequencing system to determine:
    - a) Relay logic using present relays;
    - b) Relay logic using smaller relays;
    - c) Use of solid state devices;
    - d) Redundancy and protection against single malfunction requirements for the above.
  - 2) Determine power configuration for the redundancy requirements (see 5.2.6.23.5.a).
  - 3) Study need for redundant enable-disable circuits in the ISDS system.
  - 4) Study shutdown circuits in all states to determine redundancy requirements.
  - 5) Study desirability of bringing out additional points to checkout connectors to verify internal redundancy during CST or after final vehicle erection.
  - 6) Study to determine optimum grounding system for complete vehicle (booster, Lab., Gemini, AGE).
  - 7) (Deleted)
- b. Titan III Flight Control System Design Study - The design study for the Titan III flight control system shall include the following requirements:
  - 1) Quick change capability for gains and filter constants;
  - 2) Modular design capable of operating in singular or redundant fashion;



5.2.6.23.6.b (Continued)

- 3) Redundant configuration design shall be such to minimize switch-over loads and transients;
  - 4) The system shall provide for a 25 percent increase in capacity;
  - 5) The system should allow for dynamic changes in flight;
  - 6) The system shall fail operational for the first failure during Stage 0 flight. It is a design objective that the system fail "soft", i.e., null-type failure rather than hardover for a subsequent failure.
- c. Switchover Criteria - Switchover criteria for both rapid malfunctions and slow malfunctions shall be established based on nominal and 3 sigma dispersed subsystem and launch vehicle behavior. The criteria shall be evaluated by the contractor utilizing the simulation program defined in 5.2.6.23.2, modified or complemented as required to perform rapid and slow malfunction switchover simulations at any desired time of flight. The evaluations shall consider tradeoffs between inadvertent or unnecessary switchover conditions and complete versus partial subsystem switchover. Detailed vehicle behavior and structural loading during the switchover transient shall be simulated. The loads summation shall include assessment of the dynamic loading induced by the switchover transient. Where redundancy is in a subsystem supplied by an associate, switchover criteria may be defined by the associate; however, the contractor shall interpret and evaluate the switchover in terms of the overall effect on the behavior of the vehicle.
- d. Evaluation of Program Effects of Redundant Configuration Designs - The contractor shall evaluate each design with respect to cost, effect on schedule, reliability, maintainability, crew safety, adjustment of reliability growth to correspond to vehicle number, effect on AGE and facilities, effect of redundant systems on probability of launch-on-time, and over all cost. Where effected equipment is supplied by an associate contractor, data for these items shall be supplied by the associate. The contractor shall consider the effect of redundant systems on checkout equipment and on power launch control equipment. Based upon the selected airborne redundant system configuration, checkout requirements will be identified under the TIII/MOL Compatibility study and provided to the ILC contract in the form of criteria for ground systems.

5.2.6.23.7 (U) Malfunction Detection Study - The contractor shall conduct a malfunction detection study to determine the best method of detecting the need for switchover or for abort. Methods for detection of malfunctions which require switchover during Stage O portion of flight will be particularly critical. Techniques to be considered are: a) end vehicle effects, b) generation of a third reference signal (first reference - primary system; second reference - backup system) within the malfunction detection system, and c) self-checks on major components which have this inherent capability. The malfunction detection methods will be optimized for each control system configuration alternative. For later stages of flight, the primary detection method will be a) and c). Redundancy in the malfunction sensors and associated logic will be used as necessary to meet the requirements in 3.1.3. After selection of sensors, determination of optimum settings for abort will be coordinated with McDonnell to assure spacecraft constraints are not exceeded. Tradeoffs will be conducted by Martin to obtain optimum balance between false aborts, false switchover and abort warning time.

5.2.6.23.8 (U) Coordination with Associate Contractors and SSD/Aerospace - The contractor shall coordinate the work of this study with Titan III associate contractors and the Gemini B contractor at a series of meetings called by SSD/Aerospace. Alternate meetings shall be held at SSD/Aerospace and the contractor's plant. In lieu of contractor's plant meetings, meetings may be held at the Gemini B contractor or at Titan III associate contractor's plant.

5.2.6.24 (U) Launch-On-Time Probability - The contractor shall conduct an analysis considering the selected TIII airborne systems, including crew safety and mission success modifications, facilities and AGE for the purpose of developing effectiveness and system launch variation sensitivity on meeting the required launch window. The launch-on-time probability (not including weather or range constraints, but assuming the core and SRMs are integrated and on the pad ready for checkout) shall be valid for variations in launch time of  $\pm 15$  minutes from specified launch, with launch time specified a minimum of 2 weeks in advance, and holding at the end of R count for a period of up to 20 days. The study shall categorize airborne failures occurring between major points in the countdown. Probabilities at several points in the Titan III countdown for successfully launching within the tolerance shall be determined for a given launch attempt and for successive attempts, if necessary, up to a maximum to be determined by trade-off studies. This task will be accomplished utilizing a launch-on-time probability model which has been developed by Martin for general usage. The model will be revised as necessary to analyze T-III/MOL. These studies will be oriented to evaluation of complete space system excluding the manned orbital lab and Gemini capsule and associated ground equipment. However, the model can accept data for this portion at a later time. The contractor shall define the manner and extent to which the model used in the analysis to estimate probabilities

5.2.6.24 (Continued)

deviates from the actual operational system. The ground rules, assumptions, rationale and models used by the contractor shall be reviewed and approved in writing by SSD/Aerospace. Studies concerning ground system equipment related to launch-on-time shall be conducted as part of the ILC program, and shall be an input to the probability model. Factors to be considered in this model are:

- a. Probability of success for equipment at subsystem level and at black box level as applicable based on mean-time-to-failure and other data (e.g., success/attempt);
- b. Range conditions;
- c. Weather;
- d. Maintainability downtime (e.g., duty cycles, mean-time-to-repair). Quantative requirements in accordance with MIL-M-26512C shall be established for the contributions to system downtime permitted by airborne vehicle systems with allocations to the end item level. The requirements shall be consistent with the probability of launch-on-time requirements and also, to the maximum extent practical with TIII maintainability downtime predictions in SSD-CR-63-45, entitled Maintainability Program Status Report for the 624A Program. Downtime shall be interpreted as total downtime defined in MIL-STD-778 and shall not be greater than seven (7) hours mean-time-to-restore;
- e. Recycle times;
- f. Programmed holds;
- g. Others as required.

ACED, AGC, and UTC will be required to supply data elements affecting their hardware. Data requirements will be contained in the reliability data criteria (see 5.2.3.4). Systems engineering data from Gemini and MOL contractors shall be used to determine influence of orbiting vehicle/vehicle AGE upon launch-on-time. The study will utilize accumulated weather data at WTR to determine propellant temperature and launch pressure changes. The probability of occurrence of these changes which cause an out-of-limit condition will result. The analytical program will consider rain, cloud cover, relative humidity, wind effects, nitrogen absorption and propellant stratification. At completion of the study, the contractor shall recommend modifications to improve launch-on-time probability.

5.2.6.25 (U) Launch Phase Reliability - Reliability shall be predicted for the launch phase using the data accumulated for the failure mode tabulation. The reliability prediction shall be based on the state of reliability growth at the first unmanned MOL flight.

5.2.6.26 (Deleted)

5.2.6.27 (Deleted)

5.2.6.27.1 (Deleted)

5.2.6.27.2 (Deleted)

5.2.6.27.3 (Deleted)

5.2.6.27.4 (Deleted)

5.2.6.27.5 (U) Interface Criteria for Cockpit Display - The contractor shall support the Gemini B contractor in the establishment of interface criteria for cockpit displays. Cockpit display criteria will include, consideration of analog tank pressures, lateral and longitudinal acceleration, MDS gyro outputs, solid rocket motor differential pressure sensing, guidance parameters, engine parameters, and staging parameters. The cockpit display criteria will also consider those items from the failure mode effects study which are identified as crew safety items requiring spacecraft displays. Inputs from associate contractors will be used for display criteria when associate contractor equipment is involved. Interface checkout requirements for booster generated cockpit displays will be determined.

5.2.6.27.6 (Deleted)

5.2.6.27.7 (Deleted)

5.2.6.27.8 (U) Payload Separation - A modified payload separation system utilizing explosive nuts or bolts shall be studied. Structural changes necessary shall be evaluated. Changes to the plumbing shall be considered to prevent the failure of either cold gas valve from affecting separation and to minimize payload dispersion.

5.2.6.27.9 (U) Propellant Contamination Control - The contractor shall study modification of procedures (including cleaning, sampling, and cleanliness verification) and of the propellant feed systems (AGE and airborne) to grade contamination control at all engine interfaces. Engine particle and fiber sizes should be limited to an appropriate minimum.

5.2.6.28 (U) Instrumentation and Telemetry - Review and confirm or modify the instrumentation and telemetry system as follows:

- a. Baseline Instrumentation and Telemetry Systems - Two PCM telemetry systems will be located in the transtage and will transmit all transtage measurements. One PCM telemetry system will transmit vehicle data and the other will transmit guidance data. The equipment for each system will be the same as R&D except for deletion of the guidance VSR. Two telemetry systems will be located in Stage II to transmit SRM, Stage I, and Stage II data. One telemetry system will be the R&D PCM link and the other will be the R&D SSB system.
- b. Evaluate Instrumentation and Telemetry Systems - Systems and system configurations to be evaluated will include:
  - 1) No transtage, with a PCM link added to Stage II and the PCM encoder modified to accept guidance data.
  - 2) S-Band transmission, using the various telemetry systems required by the vehicle configurations, and using one PCM telemetry link for the MOL booster instrumentation PCM data.
  - 3) Instrumentation data storage requirement.
  - 4) One hundred foot fly-away umbilical.
  - 5) Deleting single side band data system.
  - 6) Incorporating all booster instrumentation data signal conditioning in the core vehicle.
- c. Evaluate Systems and Antenna Designs - Evaluate systems and antenna designs and establish criteria for telemetry frequencies as follows:
  - 1) Review and update instrumentation electrical power requirements.
  - 2) Evaluate systems and establish criteria for utilization of the 1435-1535 or 2200-2300 MC telemetry frequencies, for use prior to 1 January 1970.
  - 3) Establish requirements for the TIII/MOL Master Program Measurement Plan. Include requirements from each booster and MOL associate contractor.

5.2.7 Develop Operations Requirements for Ground Systems

5.2.7.1 (U) Telemetry Tracking and Surveillance Study - Provide appropriate support to SSD/Aerospace on a study on telemetry tracking and surveillance parameters, based initially on the reference trajectory and later showing what changes may have to be made to the reference trajectory to accommodate tracking requirements. The effects on mission capability of requiring a certain vehicle attitude at various points in the trajectory shall be studied. The basic data will be elevation angles and look angles from certain established ground stations or new ground stations which the study may need to be established. A system compatibility analysis using existing ground stations and new ground stations as specified by SSD/Aerospace for telemetry will be analyzed using the data derived in 5.2.5. Same as above except for Tracking instead of T/M.

5.2.7.2 ILC Facility

5.2.7.2.1 (Deleted)

5.2.7.2.2 (U) AGE/Facility Criteria-Payload - The Titan III/MOL compatibility study shall include preparation of a list of ground systems requirements as input to the ILC program. This effort shall cover all areas of AGE/Facility for the Gemini B spacecraft, laboratory and launch vehicles.

5.2.7.2.3 (U) AGE/Facility Criteria Integration - Criteria shall be established defining the facility equipment and procedures required for pad abort. This effort will be conducted in coordination with the Gemini B contractor so that it is compatible with the Gemini B abort procedures.

5.2.7.2.4 (Deleted)

5.2.7.2.5 (Deleted)

5.2.7.2.6 (Deleted)

5.2.7.2.7 (Deleted - See 5.2.6.28)

5.2.7.2.8 (U) RF Transmission Checkout System Criteria - The Titan III/MOL compatibility study shall prepare a list of requirements, as inputs to the ILC program, for the ground RF transmission systems to be used for checkout and monitoring of Gemini B, laboratory communication, tracking and telemetry subsystems. The performance requirements shall be dictated by the following payload RF systems:

- a. Gemini B Spacecraft - Real time telemetry transmitter, standby telemetry transmitter, VHF voice transmitter/receiver, HF voice transmitter/receiver, recording aids, digital command system, C-band tracking beacon, and SLGS.
- b. Laboratory System - To be determined during study phase.

5.2.7.2.9 (U) Ground Display Criteria - Criteria shall be prepared for real time monitoring of launch vehicle parameters. The displays shall be used for slow malfunction detection as part of the Crew Safety System. Guidance parameters, autopilot outputs, rate gyro outputs, MOS functions, TVC manifold pressure, TVC dump command, tank and chamber pressures are among analog parameters to be considered. Discrete signals including staging, gain changes, trajectory reasonableness check and status of switch over circuitry shall also be studied. Criteria for additional parameters which are identified by the failure mode effects study as requiring real time ground displays shall also be defined. The resultant criteria shall define the type, orientation and accuracy requirements of ground displays for each parameter. Supporting analysis shall include evaluation of failure modes, preliminary decision criteria, and estimated decision time. Associate contractor inputs will be used in defining display criteria when associate contractor equipment is involved. The contractor will establish criteria for the launch and mission control centers commensurate with the objectives of the baseline and growth versions of the Titan III/MOL program. These criteria shall be provided as input to the ILC program.

5.2.8 (U) Requirements for Operation Personnel and Training - A planning, scoping and identification effort shall be accomplished in conjunction with the studies required in 5.2.2, 5.2.2.1, 5.2.3, 5.2.14, 5.2.20 and 5.2.21 to enable a contractor training program subsequent to SSD approval of the proposed ECPs/CEI Specifications. Estimates of quantities of equipment required in 5.2.20 and 5.2.21 shall be accomplished as part of this task. This activity shall result in a syllabus covering proposed training courses including course description, scope, objective, duration, and level of presentation; and in an integrated personnel certification plan to ensure a standard method of certifying personnel subsequent to the completion of these studies.

5.2.9 (U) Selection of AVE - The contractor shall identify the operational AVE and software essential to the performance of his assigned responsibilities for the MOL mission. This shall include responsibility as integrating contractor for assembly through launch and inject into orbit, and shall include the integration of associate contractor operational AVE and software requirements.

5.2.10 (U) High Risk Areas and Long Lead Items - The contractor shall identify high risk areas and long lead time items in which time, cost or performance are critical and require special attention.

5.2.11 (U) SPO Systems Requirements Review and Technical Direction - The contractor shall be prepared to support a review and technical direction meeting to be scheduled at approximately the midpoint of this effort. Emphasis will be placed on the results of trade-off studies, study results, and design decisions which may impact on MOL system performance/design. Seven days prior to the review meeting, the contractor shall furnish SSD four copies of the contractor's working drafts (rough) of the following portions of the data to be reviewed at the meeting: (a) system and expanded level flow diagrams, (b) trade studies, and (c) timelines for the following: Integration and Checkout of SSLV/Payload, Establish and Maintain Readiness, Perform Terminal Countdown, and Perform Flight Mission.

5.2.12 (Deleted)

5.2.13 (Deleted)

5.2.14 (U) Develop Requirements for Maintenance Personnel and Training - The initial requirements for maintenance personnel and contractor training shall be developed. It is recognized that these requirements will be of a preliminary nature. However, sufficient definition should be achieved to identify the scope of the effort involved as described in 5.2.8 above.

5.2.15 (Deleted)

5.2.16 (Deleted)

5.2.17 (Deleted)

5.2.18 (U) Update Interface Specifications - The contractor shall prepare addenda to existing airborne interface specifications, as required, and prepare specification criteria for new interface documents, including interfaces with the payload.

5.2.19 (U) Contract End Item Specifications for AVE - The contractor shall prepare CEI specifications in accordance with AFSCM 375-1, dated 1 June 1964.

5.2.20 (U) Estimate Quantities of AVE, OGE, Operational Facilities, Personnel and AAE - Initial estimates of the quantities of equipment and personnel required to conduct the program shall be identified with OGE and operational facility inputs from the ILC program.



5.2.21 (U) Estimate Quantities of MGE, Maintenance Facilities, Personnel and AAE - The contractor shall make estimates of requirements. Associate contractor requirements shall be integrated by the contractor. While it is clearly recognized that quantity determination can only be estimated at this time, these gross estimates are required to ensure that an adequate approach is being followed. These estimates shall be inputs from the ILC program.

5.2.22 (U) Provide Supporting Material for Airborne ECP Specification Changes - Engineering analyses, trade studies, etc., shall be provided with changes to support the recommended modifications.

5.2.23 (U) Responsibility and Relationship to Associate Contractors - In performing the foregoing systems engineering effort, the contractor shall utilize support of associate contractors in the program and shall also support these associates in the analytical work and study work assigned in their respective contracts. The relationship of the associate contractors with respect to specific studies are identified in Table 3. The contractor shall provide SSD with system design criteria for 156-inch SRMs, including performance requirements, system constraints, reliability requirements, crew safety features, etc. If, during the contractor's study, certain 156-inch data is unavailable from the potential 156-inch SRM associate(s), the contractor shall establish the required data based upon his best estimates. This data shall be documented in the design criteria mentioned above.

5.2.24 (U) Titan III/MOL Booster System Performance/Design Requirements Specification - The contractor shall prepare the systems specification, as called for by AFSCM 375-1, dated 1 June 1964, as a part of this contract effort. The Titan III/MOL system specification shall be based upon the basic TIII system, the results of this study, and an Air Force draft of the TIII/MOL system specification to be furnished not later than 15 October 1965. Associate contractor inputs to the TIII/MOL systems specification will be collected from the systems engineering data provided by the associate contractors to the integrating contractor for integration into the systems engineering data package. The system specification shall be compatible with the ILC specification produced under Contract AFO4(695)-738, and shall cross reference appropriate requirements in that specification.

Table 3 Associate Contractor Study Support

| Program Plan<br>Paragraph | Analysis   | Responsibility |     |     |      |     |    |
|---------------------------|--|----------------|-----|-----|------|-----|----|
|                           |  | MC             | UTC | AGC | ACED | MAC | AS |
| 5.2.1.1                   | Mass Properties  | I              | S   | S   |      |     |    |
| 5.2.2                     | System Compatibility   | I              | S   | S   |      | S   |    |
| 5.2.2.1                   | Integrate Functional Flow Diagram                                | I              | S   | S   | S    | S   |    |
| 5.2.2.2                   | Pre-Orbit Tech Requirements of<br>Associate Contractor (initial) | I              | S   | S   | S    | S   |    |
| 5.2.3.1                   | Cockpit Displays and Real Time T/M                               |                |     |     |      |     |    |
| 5.2.3.1.1                 | Booster Required Gemini B Displays                               | I              |     |     | S    | S   |    |
| 5.2.3.2                   | Enviorntmental Criteria  | I              | S   |     |      |     |    |
|                           | Wind Criteria  | I              |     |     |      |     |    |
| 5.2.3.3                   | Failure Environmental Model<br>Criteria                          | I              | S   |     |      |     |    |
| 5.2.3.4                   | Reliability Criteria   | I              | S   | S   | S    |     |    |
| 5.2.3.6                   | Performance/Design Data for<br>MOL-Mods                          | I              | S   | S   | S    |     |    |
| (a)                       | 15:1 Stage I Engine  | I              |     | S   |      |     |    |
| (b)                       | Incorporate Data from 7-Segment<br>and 156-inch SRM              | I              | S   |     |      |     |    |
| (c)                       | Base Heating   | I              | S   | S   |      |     |    |
| (d)                       | Brazed and Welded Fittings                                       | I              |     | S   |      |     |    |
| 5.2.3.6.1                 | Analysis of Structural Loads                                     | I              | S   |     |      |     |    |
| 5.2.5 (a)                 | Vehicle Integration Procedures                                   | I              |     |     |      |     | S  |
| (b)                       | Antenna Change Relocation  | I              |     |     |      |     |    |
| (c)                       | Normal CST and Separate Lab CST<br>vs Combined                   | I              |     |     |      |     | S  |
| (e)                       | On-Pad Ordnance Installation vs<br>Pre-Mate Installation         | I              | S   |     |      |     | S  |
| (h)                       | Individual vs Integrated RF<br>Transmission System               | I              |     |     |      |     | S  |
| (i)                       | Thrust-Time Effects of Various<br>7-Segment SRM Designs          | I              | S   |     |      |     |    |
| 5.2.6.1                   | Derive Aerodynamic Coefficients<br>for Payload Configurations    | I              |     |     |      |     | S  |
| 5.2.6.2                   | Aerodynamic Coefficient - Stage 0<br>Staging                     | I              | S   |     |      |     |    |
| 5.2.6.3                   | Shape Stage 0 Trajectory for Loads<br>and Performance            | I              |     |     |      |     |    |
| 5.2.6.4                   | Staging Boundaries and Dispersions                               | I              |     |     |      |     |    |
| 5.2.6.5                   | Determine Aerodynamic Heating                                    | I              | S   |     |      |     |    |
| 5.2.6.6                   | Determine Distributed Airloads for<br>Selected Mach No.          | I              |     |     |      |     | S  |
| 5.2.6.7                   | Determine Launch Clearance                                       | I              | S   |     |      |     |    |
| 5.2.6.8                   | Stage 0 Elastic Loads Analysis                                   | I              | S   |     |      |     |    |
| 5.2.6.9                   | Structural Loads at MOL-Transtage<br>Interface                   | I              |     |     |      |     | S  |
| 5.2.6.10                  | Establish Reference Trajectories                                 | I              |     |     | S    | S   | C  |

Table 3 (Continued)

| Program Plan<br>Paragraph | Analysis  | Responsibility |     |     |      |     |    |
|---------------------------|---|----------------|-----|-----|------|-----|----|
|                           |   | MC             | UTC | AGC | ACED | MAC | AS |
| 5.2.6.11                  | Determine TVC Fluid Requirements                      | I              | S   |     |      |     |    |
| 5.2.6.12                  | Pre-Flight Loads Analysis                             | I              |     |     |      |     |    |
| 5.2.6.13                  | Stability Analysis - Axial<br>Oscillations            | I              |     |     |      |     |    |
| 5.2.6.14                  | Autopilot Constants for Stage O,<br>I, and II         | I              |     |     |      |     |    |
| 5.2.6.15                  | Autopilot Constants for Stage III                     | I              |     |     |      | S   |    |
| 5.2.6.16                  | Autopilot Constants - Coast Phase                     | I              |     |     |      |     | C  |
| 5.2.6.17                  | Effect of Fuel Slosh on FCS                           | I              |     |     |      |     |    |
| 5.2.6.18                  | Effect of Boost Guidance on<br>Stability              | I              |     | S   | S    |     |    |
| 5.2.6.19                  | Stability During Staging                              | I              |     |     | S    |     |    |
| 5.2.6.20                  | Control System Performance<br>Tolerance               | I              |     |     |      |     |    |
| 5.2.6.22                  | Payload Capability                                    | I              |     |     | S    |     | C  |
| 5.2.6.23                  | Malfunction and Redundancy Study                      | I              | S   | S   | S    |     |    |
| 5.2.6.23.1                | Failure Mode Tabulation for<br>System Level           | I              | S   | S   | S    |     |    |
| 5.2.6.23.2                | Malfunction Effect Model and<br>Simulation            | I              | S   |     | S    | S   |    |
| 5.2.6.23.3                | Failure Mode/Failure Effect Data<br>Reduction         | I              |     |     |      |     |    |
| 5.2.6.23.4                | Motion Tapes  | S              |     |     |      | I   |    |
| 5.2.6.23.5                | Guidance and Flight Control                           | I              |     |     | S    | S   | C  |
| 5.2.6.23.6                | Design Evaluation of Redundant<br>Configurations      | I              |     |     | S    | S   | C  |
| (a)                       | Design of Redundant Systems                           |                |     |     |      |     |    |
| (b)                       | TIII FCS Design Study                                 |                |     |     |      |     |    |
| (c)                       | Switchover Criteria                                   |                |     |     |      |     |    |
| (d)                       | Evaluation of Program Effect,<br>Schedule, Cost, Etc. |                |     |     |      |     |    |
| 5.2.6.23.7                | Malfunction Detection Study                           | I              | S   | S   | S    | S   |    |
| 5.2.6.23.8                | Coordination of Malfunction and<br>Redundancy Studies | I              | S   | S   | S    | S   | C  |
| 5.2.6.24                  | Launch-On-Time Probability                            | I              | S   | S   | S    | S   | C  |
| 5.2.6.25                  | Launch Phase Reliability                              | I              | S   | S   | S    | S   | C  |
| 5.2.6.27.5                | Transtage Criteria for Cockpit<br>Display             | I              |     |     |      | S   |    |
| 5.2.6.27.8                | Payload Separation                                    | I              |     |     |      |     |    |
| 5.2.6.27.9                | Contamination Control                                 | I              | S   |     |      |     | C  |
| 5.2.6.28                  | Instrumentation and Telemetry                         | I              |     |     | S    | S   |    |
| (a)                       | Analysis of Baseline Mods                             | I              |     |     | S    | S   |    |
| (b)                       | Payload Requirements and<br>Accommodation             | I              |     |     |      | S   |    |
| (c)                       | Instrumentation Power Requirements                    | I              | S   |     | S    | S   |    |

Table 3 (Continued)

| Program Plan<br>Paragraph | Analysis   | Responsibility |     |     |      |     |    |
|---------------------------|--|----------------|-----|-----|------|-----|----|
|                           |  | MC             | UTC | AGC | ACED | MAC | AS |
| 5.2.6.28 (Continued)      |  |                |     |     |      |     |    |
| (d)                       | Systems and Criteria for New Technology Frequencies            | I              |     |     |      |     |    |
| (e)                       | Requirements for Revised Master Measurement List               | I              | S   | S   | S    | S   |    |
| 5.2.7.1                   | Tracking and Surveillance Parameters                           | S              |     |     | S    | S   | I  |
| 5.2.7.2.2                 | AGE/Facility Criteria-Payloads                                 | I              |     |     |      | S   |    |
| 5.2.7.2.3                 | AGE/Facility Criteria-Integration                              | I              | S   | S   | S    | S   |    |
| 5.2.7.2.8                 | RF Transmission Checkout System Criteria                       | I              |     |     |      | S   |    |
| 5.2.7.2.9                 | Ground Display Criteria  | I              | S   | S   | S    |     |    |
| 5.2.8                     | Requirements for Operational Personnel and Training            | I              |     |     |      |     |    |
| 5.2.9                     | Selection of AVE   | I              | S   | S   | S    | S   |    |
| 5.2.10                    | High Risk and Long Lead Time Items                             | I              |     |     |      |     |    |
| 5.2.11                    | SPO Review and Technical Direction                             | I              |     |     |      |     |    |
| 5.2.14                    | Develop Requirements for Maintenance Personnel and Training    | I              |     |     |      |     |    |
| 5.2.18                    | Update Interface Specifications                                | I              | S   | S   | S    | S   |    |
| 5.2.19                    | CEI Specifications for AVE                                     | I              |     |     |      |     |    |
| 5.2.20                    | AVE, OGE, Operational Facilities, Personnel and AAE Quantities | I              |     |     |      |     |    |
| 5.2.21                    | MGE, Maintenance Facilities, Personnel and AAE Quantities      | I              |     |     |      |     |    |
| 5.2.22                    | Airborne ECP Support   | I              |     |     |      |     |    |
| 5.2.23                    | Associate Contractor Relationship                              | I              | S   | S   | S    | S   |    |
| 5.2.24                    | Booster System Spec (A/B)                                      | I              | S   | S   | S    | S   |    |

- Note: 1. All MOL Laboratory input shall be supplied by Aerospace.
2. I = Responsible for performing/integrating analysis.
3. S = Responsible for performing support studies or supplying data.
4. C = Concurrence required prior to incorporation in associates analyses (validation).

ANNEX A

SYSTEM ENGINEERING PROCEDURES AND DOCUMENTATION IMPLEMENTATION

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SYSTEM ENGINEERING PROCEDURES AND DOCUMENTATION IMPLEMENTATION

1. GENERAL

This annex defines the systems engineering procedures and documentation requirements to be implemented by the contractor in performing the tasks required in this program plan.

2. PROCEDURES AND DOCUMENTATION

2.1 Activity Net Work - The network in Fig. A-1 shows the step by step procedures to be followed in performing the tasks described in this statement of work. The activities to be performed by both the Government and the contractor, as required by AFSCM 375-5, are identified. The relationship between the numbered functional activities of Fig. A-1 and the paragraphs of this statement of work (SSD-CR-65-67) is shown below:

| <u>Figure A-1</u><br><u>Functional Activity</u> | <u>SSD-CR-65-67, Rev 2</u><br><u>Program Plan Paragraph</u> |
|---|---|
| 1   | Contract Go Ahead   |
| 2   | 5.2.1   |
| 3   | 5.2.2   |
| 4   | 5.2.3   |
| 5   | 5.2.4   |
| 6   | 5.2.5   |
| 7   | 5.2.6   |
| 8   | 5.2.7   |
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| 11  | 5.2.10  |
| 12  | 5.2.11  |
| 13  | 5.2.18, 5.2.24  |
| 14  | 5.2.19  |
| 15  | 5.2.20  |
| 16  | 5.2.14  |
| 17  | 5.2.22  |

2.2 Functional Description - A description of the activities and the degree of compliance with AFSCM 375-5 of the functions of Fig. A-1 are contained in the paragraphs below.

2.2.1 Block 1 - Phase 1B Contract Go-Ahead - This function consists of contract go ahead for the engineering effort to define the total requirements for the TIII/MOL compatibility study. The CCN shall initiate the definition of airborne equipment necessary to meet the total system requirements of the Systems Specification prepared by the SPO. This function generally fulfills the requirements of Block 19 Exhibit I of AFSCM 375-5.

2.2.2 Block 2 - This activity is the updating of source documentation in specifications effected by the Titan III/MOL Study.

2.2.3 Block 3 - Develop Detailed Airborne Operation Functions - The effort identified by this function fulfills the requirements of block 21 Exhibit I AFSCM 375-5 to the extent specified in 5.2.2 herein.

2.2.4 Block 4 - Develop Design Requirements for Airborne Operation Functions - The effort identified by this function fulfills the requirements of block 22 Exhibit I AFSCM 375-5 to the extent specified in 5.2.3 herein.

2.2.5 Block 5 - Systems Requirements Review - SSD/Aerospace in-process reviews will be conducted to the extent specified in 5.2.4 herein, to review and evaluate the documentation resulting from the efforts of 5.2.2 and 5.2.3 herein. The intent of these reviews meet the requirements of block 23 Exhibit I AFSCM 375-5.

2.2.6 Block 6 - Perform Trade Off Studies (Operations Elements of System) - The effort identified by this function fulfills the intent of block 23 Exhibit I AFSCM 375-5 to the extent specified in 5.2.5 herein.

2.2.7 Block 7 - Develop Design Requirements (New and Changes to Existing) For Airborne Operation End Items - The effort represented by this function is the identification of design requirements resulting from studies specified in 5.2.6 herein, as a part of the design synthesis process between function identification and criteria preparation.

2.2.8 Block 8 - Incorporate Operations Requirements for Ground Systems Developed for ILC - The effort represented by this function is the identification of ground systems requirements to support TIII/MOL Systems Engineering data for continuity. This effort fulfills the requirements of Block 26 of Exhibit I of AFSCM 375-5 to the extent of 5.2.7 herein.

2.2.9 Block 9 - Develop Requirements (New and Changes to Existing For Operations Personnel and Training) - The effort identified of this function fulfills the requirements of Block 27 Exhibit I of AFSCM 375-5 to the extent specified in 5.2.2.1 and 5.2.8 herein.

2.2.10 Block 10 - Identify New AVE, and A/B GFE and Modifications to AVE, and A/B GFE - The effort consists of identifying to the Government the items of AVE A/B GFE that are required to accomplish the proposed mission. This will be accomplished by preparing addendums to existing specifications for equipment to be modified or new specifications for new equipment. This effort generally fulfills the requirements of Block 28 Exhibit I of AFSCM 375-5 to the extent specified in 5.2.9 herein.

2.2.11 Block 11 - Identify High Risk Areas and Airborne Long Lead Time Items - The effort identified by this function fulfills the requirements of Block 29 Exhibit I of AFSCM 375-5 to the extent specified in 5.2.10 herein.

2.2.12 Block 12 - Systems Requirements Review - SSD/Aerospace will conduct an in-process review to review trade studies, study results, specification addendum, flow diagrams and timelines for Integration and Checkout of the SSLV/Payload, readiness, terminal countdown and flight mission data. This review is in general accordance with the requirements of Block 30 Exhibit I AFSCM 375-5 to the extent specified in 5.2.11 herein.

2.2.13 Block 13 - Update Systems Requirements Specification - The effort identified by this function is the completion of the contractor segment of the system specification and the preparation of revisions or new interface specifications. This activity fulfills the requirements of Block 31 of Exhibit II of AFSCM 375-5 to the extent called for in 5.2.18 and 5.2.24 herein.

2.2.14 Block 14 - Prepare Part I of Detail Specifications for AVE, AGE, GFE, and Facilities - The effort consists of preparing addendums to existing specifications to the same level of detail as existing specifications for equipment to be modified and to prepare new specifications to the level of detail outlined in Block 45 Exhibit I of AFSCM 375-5 for new equipment, to the extent specified in 5.2.19 herein.

2.2.15 Block 15 - Estimate Quantities of AVE, AGE, GFE, AAE, and Facilities - The effort identified by this function fulfills the requirements of Block 53 Exhibit I AFSCM 375-5 to the extent specified in 5.2.20 herein.



2.2.16 Block 16 - Develop Requirements for Maintenance Personnel and Training - The effort identified by this block fulfills the intent of Block 40 of Exhibit I of AFSCM 375-5 to the extent specified in 5.2.14 herein.

2.2.17 Block 17 - Provide Supporting Material for Engineering Change Proposals and Specification Changes - This effort fulfills the requirements of Block 55 Exhibit I of AFSCM 375-5 to the extent specified in 5.2.22 herein.

### 2.3 Contractor Documentation

2.3.1 General - The following requirements shall be implemented for developing and documenting systems engineering data. These requirements comply with AFSCM 375-5, Exhibit II to the extent specified below.

2.3.2 Flow Diagram - The contractor shall prepare a top level flow diagram to identify and sequence the major receipt (ITL Complex) through launch functions, including refurbishment, for each system configuration. This diagram shall be based on the top system flow diagram III-1 of Vol. 1 SSD-TR-64-207. Expanded level flow diagrams shall be prepared as revised Titan III flows or new flows for each function on the top flow diagrams. The expansion of major functions shall be to a level sufficient to provide a graphic presentation of the performance, design, and test functions identified in analyses called for in SSD-CR-65-67. The contractor shall integrate the functions of Booster and MOL associate contractors with those developed by the contractor. The integrated flow diagrams shall be developed by revising existing Titan III flow diagrams or by preparing new flow diagrams for TIII/MOL peculiar functions. These flow diagrams shall be in general accordance with paragraphs 1.0 through 1.10 of Exhibit II of AFSCM 375-5 dated 14 December 1964, except that only "go" functions shall be shown, and detail methodology shall be in accordance with that used for the existing Titan III flow diagrams.

2.3.3 Function Requirements - Function requirements for each expanded level function shall be defined and documented for the tasks in the program plan. Data for each function shall be quantitatively defined and justified by the technical performance/design/test requirements that must be satisfied by equipment, facilities, and personnel. The results of this analysis shall be documented in trade-off studies in accordance with Block 24, Exhibit I of AFSCM 375-5, and on addenda to existing Form Bs or new Form Bs. The contractor shall integrate the requirements of Booster associate contractors only, with contractor data in these addenda. This documentation shall be in general compliance with paragraph 2.0 through 2.3 of Exhibit II of AFSCM 375-5 dated 14 December 1964.

2.3.4 Trade-Off Studies - Trade-off studies performed in accomplishing the tasks of SSD-CR-65-67 shall be accomplished and documented in accordance with the requirements of paragraph 3.0 through 3.7 of AFSCM 375-5 dated 14 December 1964.

2.3.5 Timelines - Time-function analyses of launch-critical functions performed as part of this program plan shall be documented as revisions to existing Titan III timelines or as new timelines. The contractor shall integrate Booster and MOL associate contractor timelines with those developed by the contractor and shall include downtime allocations in an integrated timeline for launch operations. Data sources for downtime allocations shall be the data used for the launch-on-time probability studies of 5.2.6.2<sup>1</sup>. These timelines shall fulfill the intent of paragraph 5.0 through 5.3 of Exhibit II of AFSCM 375-5 dated 14 December 1964.

2.3.6 Schematics - Functional schematics generated to support and facilitate preparation of specification changes or new specifications, shall be documented as changes to existing Titan III functional schematics. The contractor shall integrate functional schematics provided by Booster and MOL associate contractors with those generated by the contractor. The format and content of these schematics shall be in general agreement with the requirements of paragraph 4.0 through 4.5 of Exhibit II of AFSCM 375-5 dated 14 December 1964.

2.3.7 Level of Detail - Throughout the analyses and engineering studies, the level of detail to be documented by the contractor shall be limited to that needed to accomplish the following:

- a. Revisions to existing Titan III Specifications;
- b. Preparation of new CEI Specifications;
- c. Evaluation by SSD/Aerospace of vehicle and ground system requirements defined by the contractor;
- d. To relate performance/design/test requirements of the vehicle and ground systems to applicable performance/design/test requirements called for by the specifications;
- e. Evaluation during design reviews to establish that hardware design meets the system performance and operating requirements;

2.3.7 (Continued)

- f. The level of detail of the analysis in the areas of associate contractor responsibility shall be limited to that necessary to establish interfaces, and to integrate associate contractor functional requirements into the receipt (ITL Complex) through launch and refurbishment sequence of events. Systems engineering data in areas of associate contractor responsibility shall be based on flow diagrams, timelines, schematics, and Form Bs as identified herein.

2.3.8 Maintenance Analyses Documentation - Those maintenance analyses effort required by this program plan shall be documented in brief summary form on Maintenance Function Analysis C<sub>1</sub> Forms.

2.3.9 Personnel Equipment Data - Documentation of the analysis of PED to determine areas of PED where change is required shall be accomplished by revision of the PED integration criteria/test procedure preparation criteria.

2.3.10 Data Access - The contractor shall provide access to data and supporting documentation generated under this contract for purposes of review by SSD/Aerospace.

2.3.11 Data Maintenance - The system engineering data generated by the contractor shall be maintained until the end of the contract.

2.3.12 Non-Duplication - The contractor shall make a maximum utilization, by direct reference, of existing Titan III data, and shall minimize duplication of existing data wherever possible. However, all system engineering data submitted under this contract, including applicable existing Titan III data, shall be numbered in accordance with the MOL System Top Level Functional Flow Diagram to provide a complete set of MOL peculiar data.

SPECIFICATIONS

OPERATIONS  
DESIGN

SYSTEMS DESIGN

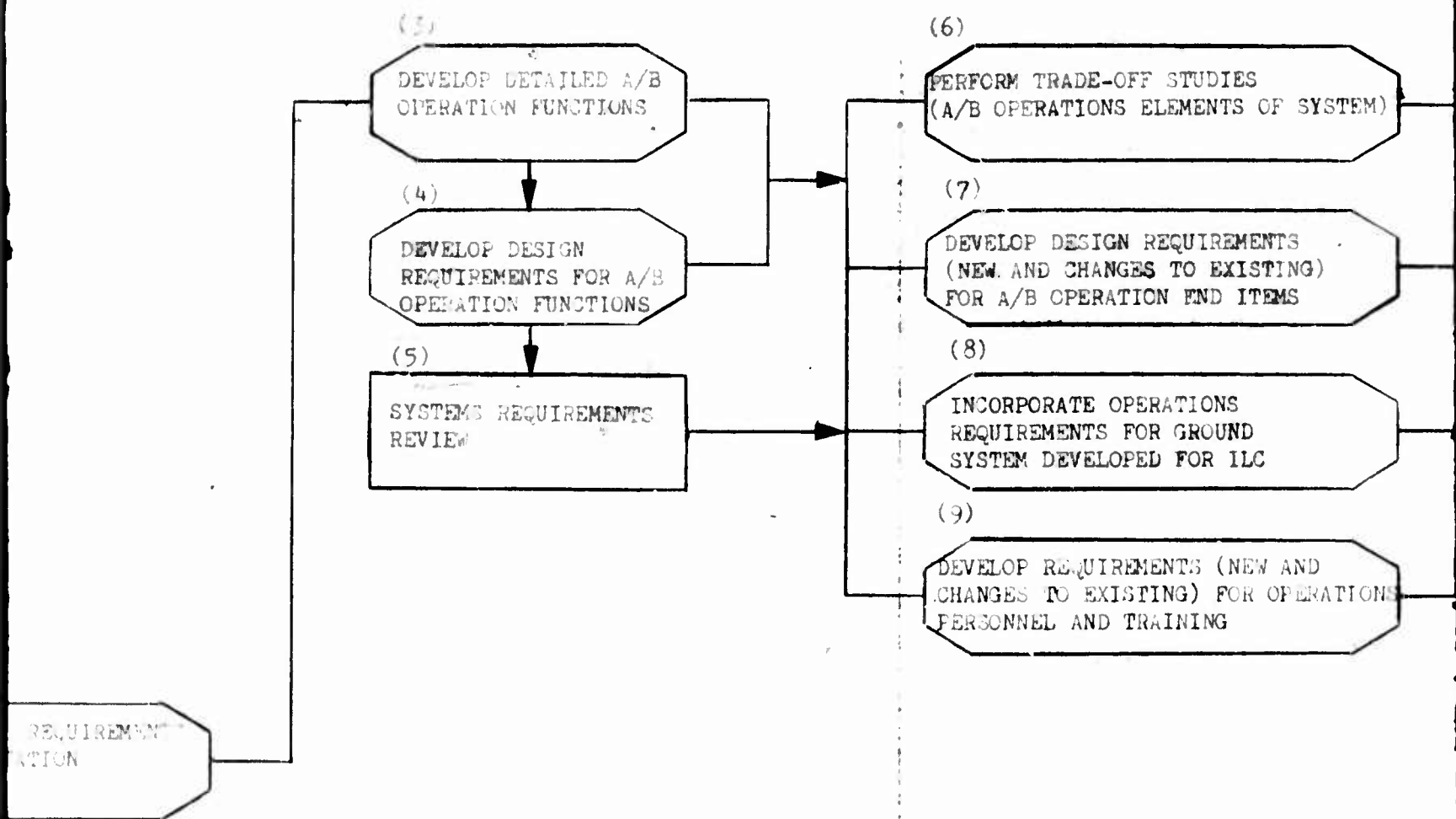
MAINTENANCE  
DESIGN

(1)

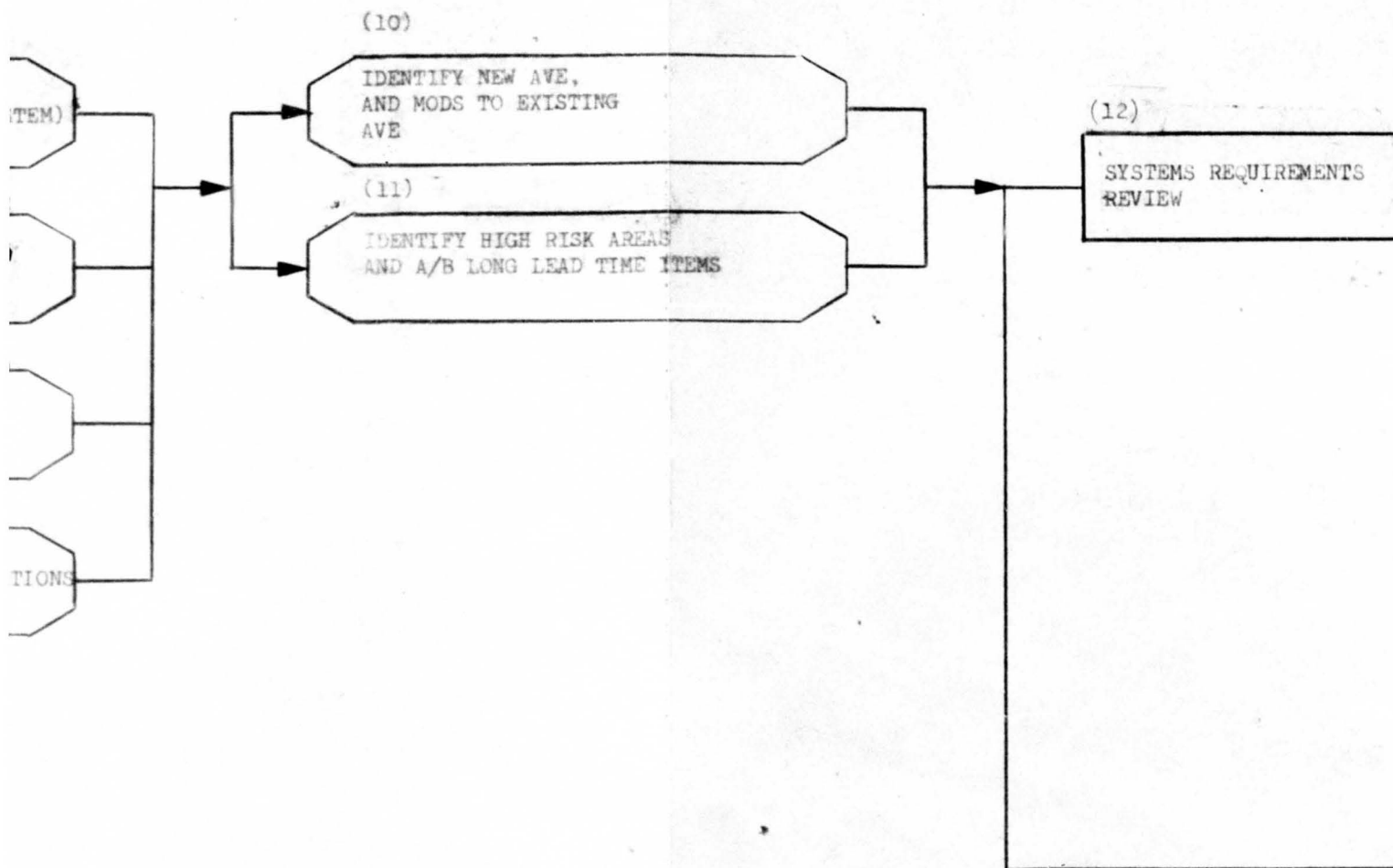
PHASE IB  
CONTRACT GO-AHEAD

(2)

IDENTIFY APPLICABLE REQUIREMENTS  
AND SOURCE DOCUMENTATION  
(MAINTAIN LIST)



2



(13)

UPDATE INTERFACE  
SPECIFICATIONS

MENTS

(16)

DEVELOP REQUIREMENTS  
FOR MAINTENANCE  
PERSONNEL AND TRAINING

9

(14)

END ITEM DETAIL SPECIFICATIONS

(15)

ESTIMATE QUANTITIES OF  
AVE REQUIRED

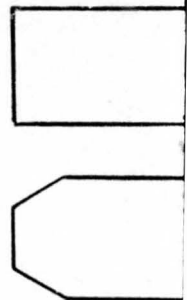
(17)

PROVIDE  
FOR ENG  
AND SPE

5



NOTE:



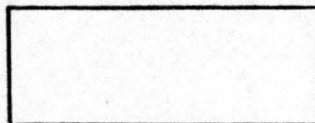
(17)

PROVIDE SUPPORTING MATERIAL  
FOR ENGINEERING CHANGE PROPOSALS  
AND SPECIFICATION CHANGES

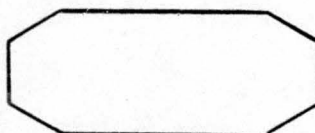
6

FIG. A-1 NETWORK FOR MOL/TIII

NOTE:



GOVERNMENT FUNCTION



CONTRACTOR FUNCTION

7

FIG. A-1 NETWORK FOR MOL/TIII COMPATABILITY STUDY